PREFACE

The present work is the result of H_2 and NO_2 sensing characteristics of nanoparticles based ZnO-resistor and Pd/ZnO Schottky diode. Hydrogen (H_2) is a colorless and odorless gas which can be used as a clean and renewable source of energy. it can be ignited easily with a very small amount of energy, as small as 0.02 mJ. The explosive range of H_2 is from 4% to 75%, and its flame is invisible. The nitrogen dioxide can significantly contribute to the acid rain, photochemical smog and ozone depletion. It is severely toxic, even at low concentration (10 -100 ppm) which aggravates the human nervous system; causes irritation to the throat, and the respiratory system.

The detection of these toxic (NO_2) and explosive (H_2) gases are very important for safety monitoring and environmental protection. Many methods can be used to accomplish gas sensing such as thermoelectric, thermo-conductive, electrochemical, potentiometric, infrared, optical and solid-state gas sensors. Among all, Solid state gas sensor is prominent because of various advantages such as inexpensive to produce, easy to miniaturize, rugged, reliable, and can be designed to operate over a low temperature range. Solid state sensors based on semiconductor metal oxide (SMO) such as ZnO, SnO_2, WO_3 etc. have been subject to extensive investigation for more than two decades due to it's long-lasting, reproducible and stable gas sensing response.

The nanostructure of these SMOs materials has shown a very surprising and enhanced response against exposed gases due to its large surface to volume ratio. Therefore, nowadays nano-particles of these SMO are considered as a very prominent sensing material in the field of gas sensors. Among all these semiconducting metal oxides, ZnO has shown promising characteristic towards gas sensing application because of its high thermally stable response. The present thesis consists of six chapters.

Chapter 1 describes the toxic, pollutant and explosive gases along with their efficient detection using solid-state gas sensors. it detects a wide variety of gases as well as easily producible. This chapters also presents the history and literature review on the resistor and Schottky diode based gas sensors using various technologies (Thick film and thin film) on several substrates (Si, alumina, SiC, GaN etc.). Motivation and scope of the thesis have been also described in this chapter.

Chapter-2 presents the Micro-gas sensors and gas sensing materials. The performance parameters of gas sensors is elaborated through sensitivity, selectivity, stability, response and recovery time. This chapter has also thrown light on transition metal dichalcogenide (TMD), semiconducting metal oxide (SMO), polymers and carbon allotropes as a prominent gas sensing materials. Among various gas sensing materials ZnO has emerged as a promising candidate because of its long-lasting, reproducible and stable gas sensing response. The strucutral and gas sensing properties of ZnO has also been described in this chapter.

Chapter-3 discusses the bottom-up approach for the synthesis of ZnO nanoparticles and its application as a ZnO-resistor based gas sensor upon exposure of various gases such as H_2, NO_2, CO_2, ethanol, propanol. The resistance variation (increasing in case of NO_2 and decreasing in the case of H_2, CO_2, ethanol, and propanol) of resistor upon different gases has been also observed in this chapter. The excellent sensitivity toward NO_2 gas has also been explained through physisorption and chemisorption mechanism.

Chapter-4 discusses the facile fabrication method of Pd/ZnO nanoparticles bases

Schottky diode on a glass substrate for detection of NO_2 gas at room temperature. The NO_2 sensing mechanism has been explained thorugh the energy band diagram of Pd/ZnO Schottky diode.

Chapter-5 extends the work done in chapter 4. This chapter has investigated the Pd/ZnO Schottky diode parameters such as barrier height and ideality factor upon exposure of H_2 gas in terms of change in I-V characteristic of Schottky diode and observed optimized result at temperature 90 °C.

Chapter-6 presents the overall conclusion of the thesis drawn from the results presented in the previous chapters. Finally, some future scopes of work in the related area of research considered in the present thesis have been briefly outlined at the end of this chapter.